

NIA Project Registration and PEA Document

Date of Submission

Jun 2025

Project Reference Number

NIA2_NESO087

Project Registration

Project Title

Network Topology Optimisation

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NIA2_NESO087

Project Licensee(s)

National Energy System Operator

Project Start

June 2025

Project Duration

0 years and 5 months

Nominated Project Contact(s)

Innovation@neso.energy

Project Budget

£300,000.00

Summary

Network Topology optimisation is a wholly manual process reliant on experienced engineers to identify potential changes to the network topology that could alleviate network constraints. This project aims to investigate the feasibility of automating NTO (Network Topology Optimisation) and assess whether it can be applied in real time alongside other network analysis tools to relieve thermal transmission constraints. A successful outcome would be the development of a model capable of running extensive studies, evaluating thousands of topology permutations, and identifying the most effective solutions to address these constraints

Preceding Projects

NIA_NGET0169 - Transmission Network Topology Optimisation

Third Party Collaborators

Ernst & Young

Nominated Contact Email Address(es)

box.so.innovation@nationalgrid.com

Problem Being Solved

Great Britain's transmission networks are under extraordinary pressure. Increases in renewable penetration, High Voltage Direct Current (HVDC) links and the decommissioning of synchronous generation has driven up thermal constraints. The cost of balancing services required to maintain grid stability have rapidly increased, costing consumers hundreds of millions of pounds per year. There is enormous industry and political pressure for solutions to the problem.

Network Topology Optimisation (NTO) is currently a wholly manual process where an experienced engineer with system knowledge identifies potential changes to the network topology that would result in optimisation in network constraint limits. It is impossible to manually optimise topology for all constraints due to the vast number of permutations and business rules associated with network topology optimisation. Automatic topology optimisation in real-time has not been implemented in any network analysis tools in industry due to the complexity of the task.

Method(s)

The project will take a work-package approach, with each of the activities falling under the following areas:

WP1: Literature Review and Benchmarking

- What has been done to date and emerging research in academia and industry internationally and within the UK to date
- International approaches to Network Topology Optimisation (NTO) including best practice and the technologies and processes supporting those approaches
- An assessment of current control room practices for NTO in NESO and a benchmark of this against industry standards, best practice and comparison against other TSOs/DNOs that use NTO

WP2: Current State Assessment

- Which technologies are being used currently, what is considered best practice, and what technologies are in development
- Assess performance metrics against benchmark
- Analysis on other technologies in other industries that could be applied to NTO (i.e. operations research, logistics and supply chain management, neural networks and other methodologies for topology optimisation, etc.)

WP3: Gap and Cost Benefit Analysis

- A gap analysis to identify areas where the current network topology optimisation techniques fall short of optimal performance
- Suggestions on opportunities for improvement
- A cost-benefit analysis to understand the potential financial impact of NTO on the bill-payer and energy system stakeholders

WP4: Implementation Plan

- A detailed implementation plan for how automated NTO can be developed and integrated within NESO's existing toolset. This can be in the form of a roadmap for NTO over the next few years and consider other programmes within NESO that could impact or be built into the development of NTO

The deliverables for each these work packages will be individual, publicly available reports that will inform NESO of the current state of NTO and allow for the making of research-based decisions such that further work can be conducted without unnecessary duplication.

In line with the ENA's ENIP document, the risk rating is scored Low:

TRL Steps = 1 (2 TRL Steps)

Cost = 1 (£300,000)

Suppliers = 1 (1 supplier)

Data Assumptions = 2 (Assumptions will be defined)

Total = 5 (Low)

Scope

This project will investigate global progress in the development of automated Network Topology Optimisation (NTO), including available technologies emerging from research that could support its implementation. It will also examine technologies and systems developed in other sectors that may be transferable to electricity networks. The research will review activities undertaken by Transmission System Operators (TSOs), Distribution System Operators (DSOs), and other System Operators (SOs) worldwide to evaluate current practices and advancements in the international landscape.

Objective(s)

The objectives of this project are:

- Understand and discover all work that has been done around automated Network Topology Optimisation (NTO) to date
- To Ascertain if there are any tools, processes, methodologies of otherwise currently in use that could be adopted by NESO.
- Understand the technologies that are available, or could be leverages for this application
- Understand the costs and benefits that an automated NTO tool would bring
- Understand that if a tool would need to be created, what would be involved

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

Not applicable

Success Criteria

The project can be deemed successful if:

- Currently available technologies for network topology optimisation (NTO) have been identified and evaluated
- A clear programme of work to transition technology from research to operations have been established.
- Discovery phase for the development of NTO tools have been conducted
- Rule set for real time operations as an input for tool has been incorporated
- Recommendations for optimisation as an output to engineers in planning or real time operations has been provided.

Project Partners and External Funding

Ernst & Young LLP. No external funding contribution

Potential for New Learning

The project expects to learn what the current state of automated Network Topology Optimisation is in academic research and industry, and aims to understand what is needed to develop methodologies to a level of operational readiness that it can be used for active control processes. At the end of a project, the project learning, including recommended next steps will be available on the ENA Smarter Network Portal.

Scale of Project

This project is a desk-based research project that will explore the technologies and research around automated NTO across international electricity systems.

Technology Readiness at Start

TRL2 Invention and Research

Technology Readiness at End

TRL4 Bench Scale Research

Geographical Area

The project will be undertaken and work done in GB, but with discussions with industry stakeholders (including TSOs) taking place across the globe

Revenue Allowed for the RIIO Settlement

none

Indicative Total NIA Project Expenditure

£300,000

Project Eligibility Assessment Part 1

There are slightly differing requirements for RIIO-1 and RIIO-2 NIA projects. This is noted in each case, with the requirement numbers listed for both where they differ (shown as RIIO-2 / RIIO-1).

Requirement 1

Facilitate the energy system transition and/or benefit consumers in vulnerable situations (Please complete sections 3.1.1 and 3.1.2 for RIIO-2 projects only)

Please answer **at least one** of the following:

How the Project has the potential to facilitate the energy system transition:

Electricity system constraints have resulted in the curtailment of renewable energy at times when it could provide a large share of the national demand. Understanding the methods and tools available for how best to map and control the network would provide a route forwards to minimise curtailment and mitigate the impact of constraints, aiding in the proliferation of renewables in the electricity system.

How the Project has potential to benefit consumer in vulnerable situations:

N/A

Requirement 2 / 2b

Has the potential to deliver net benefits to consumers

Project must have the potential to deliver a Solution that delivers a net benefit to consumers of the Gas Transporter and/or Electricity Transmission or Electricity Distribution licensee, as the context requires. This could include delivering a Solution at a lower cost than the most efficient Method currently in use on the GB Gas Transportation System, the Gas Transporter's and/or Electricity Transmission or Electricity Distribution licensee's network, or wider benefits, such as social or environmental.

Please provide an estimate of the saving if the Problem is solved (RIIO-1 projects only)

N/A

Please provide a calculation of the expected benefits the Solution

N/A – research project

Please provide an estimate of how replicable the Method is across GB

This would be widely applicable across the DNOs and TSOs in GB, as the research would be useful to all the networks that operate across the system.

Please provide an outline of the costs of rolling out the Method across GB.

The costs of rolling out this research would be minimal to none, as the results will be made public and would be shared through both normal methods of dissemination, as well as through the publication of results on the ENA website and more widely with industry.

Requirement 3 / 1

Involve Research, Development or Demonstration

A RIIO-1 NIA Project must have the potential to have a Direct Impact on a Network Licensee's network or the operations of the System Operator and involve the Research, Development, or Demonstration of at least one of the following (please tick which applies):

- ☐ A specific piece of new (i.e. unproven in GB, or where a method has been trialled outside GB the Network Licensee must justify repeating it as part of a project) equipment (including control and communications system software).
- ☐ A specific novel arrangement or application of existing licensee equipment (including control and/or communications systems and/or software)
- ☐ A specific novel operational practice directly related to the operation of the Network Licensees system

- ☐ A specific novel commercial arrangement

RIIO-2 Projects

- ☐ A specific piece of new equipment (including monitoring, control and communications systems and software)
- ☒ A specific piece of new technology (including analysis and modelling systems or software), in relation to which the Method is unproven
- ☐ A new methodology (including the identification of specific new procedures or techniques used to identify, select, process, and analyse information)
- ☐ A specific novel arrangement or application of existing gas transportation, electricity transmission or electricity distribution equipment, technology or methodology
- ☐ A specific novel operational practice directly related to the operation of the GB Gas Transportation System, electricity transmission or electricity distribution
- ☐ A specific novel commercial arrangement

Specific Requirements 4 / 2a

Please explain how the learning that will be generated could be used by the relevant Network Licensees

The learnings from this project would be replicable to other networks, as the results would inform them of the tools, methodologies and approaches that could be used from a network control perspective

Or, please describe what specific challenge identified in the Network Licensee's innovation strategy that is being addressed by the project (RIIO-1 only)

N/A

Is the default IPR position being applied?

- ☒ Yes

Project Eligibility Assessment Part 2

Not lead to unnecessary duplication

A Project must not lead to unnecessary duplication of any other Project, including but not limited to IFI, LCNF, NIA, NIC or SIF projects already registered, being carried out or completed.

Please demonstrate below that no unnecessary duplication will occur as a result of the Project.

Through numerous conversations and cross-checking previous research, as well as further discussions with industry stakeholders, duplication will be avoided

If applicable, justify why you are undertaking a Project similar to those being carried out by any other Network Licensees.

N/A

Additional Governance And Document Upload

Please identify why the project is innovative and has not been tried before

This is a research project that will investigate novel developments in automated network topology optimisation to date. This technology is still in the very early stages of development, and there are no commercially ready solutions available that are known. This project hopes to understand the latest research and developments in the technology to date and understand better what would be needed to develop it to a more operationally ready point.

Relevant Foreground IPR

- Report into the current state of automated network topology optimisation in academia and industry to date
- Report into the current state of the technology and where other similar tools could be used to help advance the technology
- Gap and cost benefit analysis into developing the tool further

- Implementation plan should the cost benefit analysis suggest further work be done

Data Access Details

Data for this project and all other projects funded under the Network Innovation Allowance (NIA), Network Innovation Competition (NIC) or the new Strategic Innovation Fund (SIF) can be found or requested in a number of ways:

1. A request for information via the Smarter Networks Portal at <https://smarter.energynetworks.org>, to contact select a project and click 'Contact Lead Network'. National Energy System Operator already publishes much of the data arising from our innovation projects here so you may wish to check this website before making an application.
2. Via our Innovation website at <https://www.neso.energy/about/innovation>
3. Via our managed mailbox innovation@nationalenergyso.com

Details on the terms on which such data will be made available by National Energy System Operator can be found on our website:

[Data Sharing Approach | National Energy System Operator](#).

Please identify why the Network Licensees will not fund the project as apart of it's business and usual activities

The outputs of this are not known, and there is risk in the outputs of the project not being useful, hence innovation funding was decided as the best route forwards. Due to the relevance to other network licensees, there is a large potential benefit to sharing the knowledge and outputs of this project, which the NIA facilitates.

Please identify why the project can only be undertaken with the support of the NIA, including reference to the specific risks(e.g. commercial, technical, operational or regulatory) associated with the project

Due to the nature of the project, including the risks around no guaranteed outcomes for further development of future projects, as well as the opportunities for other networks to benefit from this research, the NIA funding route was decided as the best approach to funding this activity.

This project has been approved by a senior member of staff

☒ Yes